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**SANDIA NATIONAL LABORATORIES
CIVILIAN RADIOACTIVE WASTE MANAGEMENT
TECHNICAL PROCEDURE (TP)**

TP-096

PRESSURE TRANSDUCER CALIBRATION AT NEW ENGLAND RESEARCH, INC.

Revision 01

Effective Date: 10/09/03

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10/03/03
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10/03/03
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10/06/03
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(Reviewer signatures above document the review and resolution of comments.)

REVISION HISTORY

<u>Revision</u>	<u>Description</u>
0	Initial issue
1	TP-096 was deactivated during Audit BSC-ARC-01-010. It is now reactivated for additional work to be performed. No major technical revisions were required from the previous revision, only references to current procedures and other minor editorial revisions.

1.0 Scope and Objective

The objective of this Technical Procedure (TP) is to define the process for New England Research, Inc. (NER) to calibrate a pressure transducer (PT) for use in mechanical properties experiments. This procedure is intended for implementation in a laboratory environment, in conjunction with work for the Yucca Mountain Project (YMP).

2.0 Prerequisites

Before performing work under this technical procedure, personnel must be trained by the author and/or the Principal Investigator (PI), and they must demonstrate their proficiency in performing the work in this procedure. The PI has the responsibility for generating a record of the personnel proficiency training, as well as the responsibility that work is performed and documented in accordance with this procedure.

The personnel using this procedure are responsible for ensuring that a controlled copy of this procedure is available and used for performing the work in this procedure.

3.0 Description of Activity

Pressure transducers are used during experiments on rock samples to measure the pore and/or confining pressures being applied to the samples. The experiments are conducted under both room and high temperature conditions. The PTs are isolated from the high temperature environment during the experiments. To accurately compute pressure from pressure transducer output voltage, it is critical that the relationship between the output voltage and the pressure it represents is known. Each PT is evaluated in terms of accuracy, combined error, and reproducibility. The output voltage of the PT (along with the other data) is monitored and recorded by the data acquisition system (DAS) during experiments so the values of the various mechanical properties may be calculated. At least annual calibrations of the active PTs against a laboratory standard PT with a certified calibration traceable to the National Institute of Standards and Technology (NIST) will ensure the correct values of pressure are being recorded during experiments and system calibrations. The laboratory standard PT at NER will be calibrated on an annual basis by an independent calibration facility.

4.0 Activity Process

The PT calibration is conducted with the PT and the DAS configured as they are during experiments, so that the calibration is carried out in an "as used" condition.

During the calibration, as during experiments, the PT output voltage is conditioned and amplified with a signal conditioning system. The amplified output voltage is read directly from the video screen of the DAS. The values recorded on the Pressure Transducer Calibration Data Sheet (PTCDS) during the calibration will be read directly from the DAS screen. In this way, the response of the PT during calibration, as measured by the DAS, will precisely reflect its response during experiments.

All calibration information will be recorded on the PTCDS in accordance to the requirements specified in AP-12.1Q.

1. Document the unique identification of the PT on the PTCDS.
2. Connect the subject PT and the laboratory standard in series to the same pressure source. A servo-controlled intensifier generates the pressure.
3. Make certain the subject PT is configured as it is during experiments.
4. Utilizing the servo-controlled intensifier, apply a pressure of approximately 7 MPa to the pressure system. Allow the pressure to stabilize a minimum of five (5) minutes. Check for leaks, and tighten fittings as necessary.
5. Release the pressure, allowing it to reach ambient by slowly opening the relief valve.
6. With a calibrated digital voltmeter, measure the input voltages to the PTs. Record these values on the PTCDS.
7. While the PTs are being subjected to only ambient pressure, measure the output voltages of the subject PT with the DAS and the laboratory standard with the voltmeter. Record these values on the PTCDS.
8. Close the relief valve.
9. Utilizing the servo-controlled intensifier, increase the pressure to 7.0 MPa in increments of approximately 0.7 MPa. At each increment, record the output voltage of each PT on the PTCDS. The output voltage of the subject PT is taken from the DAS screen, while that of the laboratory standard is taken from the voltmeter.
10. Reduce the pressure to ambient in increments of approximately 0.7 MPa using the servo-controlled intensifier. At each increment, record the output voltages of each PT in the manner specified in Step 9.
11. Open the relief valve and repeat steps 7-10, then go on to Step 12.
12. Plot the calibration test results utilizing standard software. Plot the pressure (as calculated from its scale factor and output voltage) measured with the standard PT as a function of the output voltage of the PT being calibrated. The mean slope of the least-squares fit lines to the increasing pressure portion of the two sets of data is the scale factor (in MPa/V) for the subject PT. Evaluate the results of the calibration in terms of accuracy, combined error (i.e., nonlinearity and hysteresis), and reproducibility.
 - a. Accuracy: The mean deviation between the pressure values measured by the standard PT and those calculated for the subject PT using the new scale factor. This quantity is expressed as a percentage of the full-scale output of the subject PT.

- b. Combined error: A combination of the following two errors. This quantity is expressed as a percentage of the full-scale output of the subject PT.
 - i. Nonlinearity: The maximum difference in voltage between the calibration data and the linear fit to the data at a given pressure.
 - ii. Hysteresis: The maximum difference between subject PT outputs for the same applied pressure; the two sets of data are obtained during the loading and unloading cycles of the calibration.
 - c. Reproducibility: The difference in the scaling factors determined during succeeding calibration runs. This quantity is expressed as a percentage of the previous scaling factor.
13. The calibrated PT must meet or exceed the tolerances given below:
- a. Accuracy: $\pm 0.5\%$
 - b. Combined Error: $\pm 2\%$
 - c. Reproducibility: $\pm 2\%$

If the calibration results do not meet the specifications, the problem must be solved and an acceptable calibration performed prior to using the PT in further experiments.

5.0 Safety

There are no special safety hazards, only the normal hazards of the equipment. Operations will be in accordance with safety requirements of the facility where the work is being performed and that of the employer of person(s) performing the work.

6.0 Nonconformances, Deviations, and Corrective Actions

Any nonconformances or deviations must be reported to the PI as soon as possible. Deviations, deficiencies and corrective actions must be determined and documented in accordance with AP-16.1Q, *Condition Reporting and Resolution*.

7.0 QA Records

QA records, and any corrections or changes thereto, generated as a result of implementing this procedure will be prepared and submitted as inclusionary QA records (QA:QA) by the PI in accordance with AP-17.1Q, *Records Management*.

The QA records include:

- Proficiency training records (Section 2.0)
- Calibration records of the standard PT
- Pressure transducer Calibration Data Sheets (PTCDS) (Appendix A)

8.0 References

AP-12.1Q, *Control of Measuring and Test Equipment and Calibration Standards*

AP-16.1Q, *Condition Reporting and Resolution*

AP-17.1Q, *Records Management*

Appendix A

PRESSURE TRANSDUCER CALIBRATION DATA SHEET (PTCDS)

Unique identifier of pressure transducer to be calibrated _____

Date of calibration _____ Date of last calibration _____

Calibration Procedure Number and Revision _____

Unique identifier of standard pressure transducer _____

Date of last calibration of standard pressure transducer _____

Subject PT input voltage: _____ Standard PT input voltage: _____

First Cycle					Second Cycle			
Loading		Unloading			Loading		Unloading	
PT	Standard	PT	Standard		PT	Standard	PT	Standard

Calibration Results

Accuracy: _____% Combined Error: _____% Reproducibility _____%

Based on the evaluation of the accuracy, combined error and reproducibility of the data, the PT is (check one): In Specification _____ Out of Specification _____

Note: If "In Specification", the PT calibration is completed. If "Out of Specification", then note suspected problem(s) below, rerun the calibration and take appropriate steps to mark data collected with this PT since previous calibration.

Comments: _____

Work performed by: _____
Printed _____ Signed _____ Date _____

Company/Division: _____

Location of Work: _____